REPORT

OF THE

Department of Plant Pathology

OF THE

New Jersey Agricultural College Experiment Station

New Brunswick, N. J.

BY

MELVILLE T. COOK, PH.D.

FOR THE YEAR ENDING
JUNE 30, 1921

IMPERIAL BUR
15 OCT 1922
OF MYCOLOGY

TRENTON, N. J.
PUBLISHED BY THE STATE
—
1922

REPORT OF THE DEPARTMENT OF PLANT PATHOLOGY

Department of Plant Pathology

MELVILLE T. COOK, PH.D., *Plant Pathologist.*

WILLIAM H. MARTIN, PH.D., *Associate Plant Pathologist.*

ROBERT F. POOLE, PH.D., *Assistant Plant Pathologist.*

C. M. HAENSELER, PH.D., *Assistant Plant Pathologist.*

*GORDON W. FANT, B.SC., *Fellow and Assistant in Plant Pathology.*

WILLIAM D. MOORE, B.SC., *Fellow and Assistant in Plant Pathology.*

*Appointed August 1, 1920.

CONTENTS

	PAGE
INTRODUCTION	423
EPIDEMICS	425
OTHER IMPORTANT DISEASES	425
COOPERATIVE WORK WITH THE STATE DEPARTMENT OF AGRICULTURE	426
NEEDS OF THE DEPARTMENT	426
THE HERBARIUM	427
DISEASES OF THE YEAR	427
REPORT OF POTATO SPRAYING TESTS	435
INFLUENCE OF SULFUR ON THE CONTROL OF POTATO SCAB	442
INOCULATED VS. UNINOCULATED SULFUR FOR THE CONTROL OF POTATO SCAB	449
THE FERTILIZER VALUE OF SULFUR FOR POTATOES	453
STUDIES OF THE RELATION OF MATURITY TO VIGOR IN SEED POTATOES	456
CELERY DISEASE INVESTIGATIONS	461
REPORT OF SPRAYING TEST AT CAMPBELL'S SOUP FARMS	463
INVESTIGATION OF HORSE RADISH ROOT ROTS	464
INVESTIGATION OF SWEET POTATO DISEASES	466
STUDIES ON EGGPLANT WILT	469
SPRAYING EXPERIMENT FOR THE CONTROL OF PEAR FRUIT AND LEAF SPOT	473
FOLIAGE INJURIES	475

Report of the Department of Plant Pathology

MELVILLE THURSTON COOK

INTRODUCTION

The organization of the department during the past year was very similar to that of the preceding year. Dr. Wm. H. Martin, associate plant pathologist, continues with us as potato specialist and devotes a considerable part of his time to the study of the diseases of potatoes. His special problems in pathology were the control of common scab of the potato by the use of sulfur and spraying for the control of foliage diseases. His report will be found on p. 435-460.

Dr. R. F. Poole, fellow in plant pathology and assistant plant pathologist in charge of work on diseases of sweet potatoes and tomatoes, completed his work on "The Root Rot of the Celery" and received the degree of Doctor of Philosophy on June 14. He has also done considerable work on the root rot of the horse-radish (p. 461-468). He will continue with us as assistant plant pathologist, giving practically all of his time to the study of the diseases of sweet potatoes and tomatoes.

Dr. C. M. Haenseler, New Jersey Zinc Company Fellow, completed his work on "Fungi Injurious to Paints" and received the degree of Doctor of Philosophy on June 14. During the past year he did some work also on the control of the pear fruit and leaf spot (p. 473-474) and the eggplant wilt (p. 469-472). He will continue with us next year as instructor in botany and plant pathology.

William D. Moore (Clemson College, 1920) is fellow and assistant in plant pathology. He is giving special attention to the study of the root rots of corn and peas.

Gordon W. Fant (Clemson College, 1920) is fellow and assistant in plant pathology. He is giving special attention to the study of the brown rot of the peach and to seed-bed diseases.

Research

The research work in progress involves the following problems:

In the charge of Mel. T. Cook:
1. The influence of Bordeaux and other spray mixtures on potatoes.
2. The influence of mosaic and leaf roll on the yield of potatoes.
3. The transmission of *Sclerotinia cinerea* from year to year.
4. Studies on the morphology of peach yellows.
5. Causes of tomato rots.
6. Removal of fruit-tree cankers.
7. Diseases of licorice.

In the charge of Wm. H. Martin:
1. Control of foliage diseases of the potato by applications of Bordeaux mixture.
2. Investigation of the use of elemental sulfur for the control of common scab of potatoes.
3. A study of the fertilizer requirements of potatoes.
4. Investigations of tuber-borne diseases.
5. Physiological studies of seed potatoes.

In the charge of R. Frank Poole:
1. Root rot of celery.
2. Root rot of horse-radish.
3. A study of stem rot control of sweet potatoes by seed selection.
4. A study of soil treatments as affecting the control of "soil rot," "pit" or "pox" of sweet potatoes.
5. A study of the dissemination and cause of scurf of sweet potatoes under different soil conditions.
6. A study is being made in general of all storage and field rots of sweet potatoes.

In the charge of C. M. Haenseler:
1. A new wilt disease of the peach.

In the charge of W. D. Moore:
1. Root rot of the pea.
2. Root rot of corn.
3. Control of cherry leaf spot.
4. Control of strawberry leaf spot.

In the charge of G. W. Fant:
1. Brown rot cankers of the peach.
2. Control of seed-bed diseases.
3. Control of the fruit and leaf spot of the pear.
4. Comparative testing of spray and dust for control of apple diseases.

Publications

The Station publications contributed during the year by the department of plant pathology are Bulletin 345, Circulars 122 and 123, and papers of the Journal Series, Nos. 12, 21, 26, 27, and 29.

EPIDEMICS

The rainfall during the spring, summer and fall of 1920 was heavier than usual and weather conditions were very similar to those of 1919. The winter of 1920-21 was exceptionally mild. The early part of March, 1921, was very warm, followed by freezing weather the latter part of March and the early part of April. Several diseases have been severe enough to be listed as epidemics. They are as follows:

1. *The brown rot of the peach* was exceptionally severe in 1919 and 1920, the blossom blight form being very abundant. The early frosts in 1921 killed most of the peach buds. The blossom-blight form of brown rot was severe in some few orchards that escaped the frost.

2. *The late blight of the potato* was very abundant during the latter part of the season of 1920. A more complete discussion will be found on page 435.

3. *The common scab of the potato* was very abundant again in 1920. Dr. Martin reports more fully upon its prevalence, and his studies on its control by the use of sulfur (page 442).

4. The leaf spot of the cherry was very destructive in 1920. It was the subject of one orchard experiment by Dr. C. M. Haenseler and is reported on page 442. It is very severe also in 1921.

5. *The eggplant wilt* continues to be a very important disease. It was the subject of an experiment by Dr. Haenseler and is reported on page 469.

6. *The black leg of the cabbage* is a destructive disease which was very abundant in some places, especially in Camden county. This crop should receive special attention of a well trained plant pathologist.

7. *A disease of tomatoes* which we have designated as *streak* was very destructive. This disease has been observed for several years but was not of much importance until 1920. The Experiment Station literature for a period of nearly thirty years contains references to this or a very similar disease. The disease is more or less prevalent in the greenhouses during the winter and has been the subject of special study by Dr. C. R. Orton of the Pennsylvania Experiment Station. The same or a similar disease is reported from the Pacific Coast. It may be the same as the Grand Rapids wilt. It should receive careful attention of a trained plant pathologist.

8. *A bacterial rot of seed potatoes* after planting was very prevalent in the state, especially in Monmouth county during the early spring of 1921. It was mostly due to *Bacillus vulgarus* but was complicated by the presence of a small amount of *Fusarium* sp. and by wire-worms in many fields. In some cases the losses were quite heavy.

OTHER IMPORTANT DISEASES

Other very important diseases which are worthy of special attention are:

1. *The root rot of the pea* which was so very destructive in 1919 was of little importance in 1920, but an examination of the fields showed that the organism was present. Evidently the weather conditions were unfavorable for its development. It is very destructive in 1921 and will probably result in reduced acreage in the future. Mr. Moore is giving some attention to the problems but it is of sufficient importance to require the full time of a trained man.

2. *The leaf and fruit spot of the pear and quince (Fabrea maculata)* (Lev. Atk.) was quite severe on the foliage but the pear crop was small. Experimental spraying for the control of this disease was carried on by Dr. C. M. Haenseler. The results are given on page 473. The work is being continued by Mr. Fant.

3. *The root rot of celery* is the subject of Dr. Poole's special work. A brief report of his work will be found on page 461. A complete report will be published in bulletin form.

4. *The root rot of corn* was less severe than usual but is of such great importance that it has been assigned to Mr. Moore for special study.

5. *The root rot of horse-radish* continues to be a very destructive disease. Dr. Poole's report on this disease will be found on page 464.

6. *The cherry leaf spot* was very severe in 1920 and again in 1921. It was the subject of an orchard test.

7. *The diseases of small fruits* are the causes of very heavy losses which are not generally recognized by the growers. We should have a careful survey of these diseases and some provisions should be made for their study.

8. *The Fusarium wilt* of the tomato is prevalent in South Jersey and the growers do not realize its importance. It should receive attention from the standpoint of developing resistant varieties. It is likely to become an extremely serious disease in the very near future.

9. *Seed-bed diseases* due to several causes are becoming more and more important. This problem has been assigned to Mr. Fant for special study.

COOPERATIVE WORK WITH THE STATE DEPARTMENT OF AGRICULTURE

A great deal of the work of this department is closely associated with the work of the New Jersey Department of Agriculture. Unfortunately, we do not have the necessary funds for scouting for such diseases as potato wart and blister rust of the white pine, which are likely to be introduced at any time. Fortunately there has been no cases of "take all," flag smut or nematode of wheat reported thus far. The nurseries are inspected annually and a close watch is kept on nursery stock coming into the state. Certification of seed potatoes is being carried on with encouraging results. Some little scouting is done in cooperation with the United States Bureau of Plant Industry.

NEEDS OF THE DEPARTMENT

The force of workers is not large enough to meet the increasing demands for work on plant diseases. Consequently, workers in other departments, who are not trained in plant pathology, sometimes respond to these demands with results that are not altogether satisfactory. The greatest efficiency and economy cannot be obtained by employing men to do work for which they are not trained.

The most urgent needs are as follows:

1. A well trained plant pathologist is needed to conduct and direct many of the field tests which are urgently needed. Some of this work could very properly be handled by a well trained extension pathologist.

2. One or more well trained men are needed for research on the more complicated and difficult diseases, such as yellows, mosaics and similar diseases.

3. We are in very great need of a trained plant pathologist to conduct experimental work for the development of disease-resistant strains. This is one of the most fruitful lines of work for development at this time. Some of the most important problems are the root rot of the pea, the wilt of the tomato, the wilt of the eggplant and the black leg of cabbage.

4. The diseases due to soil organisms, especially the wilt diseases, are attracting more and more attention. They are complicated with such physiological factors as moisture and temperature and require the attention of especially trained men.

5. The diseases of grain and forage crops, small fruits and vegetables are causing heavy losses and should receive attention. The losses are not appreciated by the growers.

6. Many of the storage rots of fruits and vegetables, especially sweet potatoes, are due to the same organisms as those that cause heavy losses in the field. Much of the loss in transportation also is due to these same causes. These problems should be studied by trained men.

THE HERBARIUM

The herbarium, which was at one time an exceptionally good collection of plants for study, has been neglected for many years. We are in great need of a well kept herbarium of parasitic fungi. Our working conditions are such that we have not added to nor given proper care to the existing collections. The mounted plants should be gone over very carefully and put in place and the large collection of unmounted plants (mostly fungi) should be mounted and carefully distributed so that they can be used. Prof. G. W. Martin has given some attention to this work during the past year but his time has been very limited. In connection with the herbarium some arrangements should be made for keeping a more satisfactory record of the diseases reported each year.

DISEASES OF THE YEAR

The most important diseases of the year as collected by the members of the department and sent in by correspondents are as follows:

Alfalfa

Leaf Spot (*Pseudopiziza medicaginis* (Lib.) Sacc.). This disease was very severe but probably no more severe than in previous years. The diseased leaves fall more readily than healthy leaves and the loss is quite heavy.

Other Leaf Spots due to various causes which have been recorded in previous reports were found occasionally but were of no importance.

Ampelopsis

Leaf Spot (*Phyllosticta ampelopsidis* Ell. & Mart.). This disease was less prevalent than usual and of little importance.

Apple

CROWN GALL AND HAIRY ROOT (*Bacillus tumefaciens* S. & T.). Common on the apple and many other plants. Many apple and peach trees are no doubt weakened by this disease. It is doubtless the cause of poor growths in many cases.

BLACK ROT (*Sphæropsis malorum* Pk.). Very common but no more severe than usual.

BITTER ROT (*Glomerella rufomaculans* (Berk.) S. & van S.). Present but not a serious disease.

BLOSSOM END ROT (*Alternaria* sp.). Very common but not serious. It is very often associated with arsenical injury.

JONATHAN SPOT (*Alternaria* sp.). Very abundant.

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) DeToni). Not serious in many orchards.

BLOTCH (*Phyllosticta solitaria* E. & E.). Very severe on the Smith Cider variety.

SOOTY BLOTCH (*Phyllachora pomigena* (Schu.) Sacc.). Not important in well sprayed orchards.

SCAB (*Venturia inequalis* (Cooke) Wint.). Common, especially in unsprayed orchards. More prevalent in 1921 than in 1920.

RUST (*Gymnosporangium juniperi-virginianæ* Schw.). Very severe in a few localities.

FRUIT SPOT (*Cylindrosporium pomi* Brooks). Quite serious in several orchards which were not well sprayed.

MILDEW (*Sphærotheca mali* (Duby) Burr.). Occasional.

BLISTER CANKER (*Numularia discreta* (Schw.) Tull.). Occasional.

STIPPEN (?). Very common.

WATER CORE (?). Occasional.

LOW TEMPERATURE in early spring, resulting in leaf fall later in the season.

Asters

YELLOWS (cause unknown). This disease is more or less prevalent every year.

WILT (*Fusarium* sp.). Occasional.

Beans

ANTHRACNOSE (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav.). Prevalent throughout the state and destructive.

LEAF AND POD SPOTS (*Diaporthe phaseolus* (C. & E.) Sacc.). Prevalent especially in the southern part of the state, but not very destructive.

DOWNY MILDEW (*Phytophthora phaseoli* Thaxter). Very abundant and very severe throughout the state.

ROOT ROT (*Rhizoctonia*). Very common on the roots and sometimes very destructive.

RUST (*Uromyces appendiculatus* (Pers.) Lev.). Rare.

BACTERIAL BLIGHT (*Pseudomonas phaseoli* E. F. Smith). Occasional early in the season. More prevalent than usual in 1921.

Beets

LEAF SPOT (*Cercospora beticola* Sacc.). Very abundant but not considered of any importance.

Blackberry

ANTHRACNOSE (*Glœosporium venetum* Speg.). Common but of relatively little importance.

LEAF SPOT (*Septoria rubi* West). Common but of very little importance.

RUST (*Gymnoconia peckiana* (Howe) Tranz.). Common and sometimes destructive.

(See Dewberry and Raspberry)

Cabbage, Cauliflower and Kohlrabi

BLACK LEG (*Phoma lingam* (Tode) Desmaz.). Prevalent in the southern part of the state and very severe in Camden county.

YELLOWS (*Fusarium conglutinans* Wollenw.). Occasional.

BLACK ROT (*Pseudomonas campestris* (Pammel) Smith). Occasional, and widely distributed throughout the state.

CLUB ROOT (*Plasmodiophora brassicæ* Wor.). Occasional. Sometimes very destructive.

Cantaloupe

(See Muskmelon)

Carnation

RUST (*Uromyces caryophyllinus* (Schrank) Wint.). Common but not serious.

ROOT ROT (*Corticium vagum* B. & C. var. *solani* Burt.). Common but not serious.

Catalpa

LEAF SPOT (*Phyllosticta catalpæ* Ell & Mart.). Common and sometimes the cause of heavy leaf fall.

Cedar

RUST (*Gymnosporangium juniperi-virginianæ* Schw.). Very abundant in restricted localities throughout the state. Reported from Monmouth, Burlington and Cape May counties.

Celery

EARLY LEAF BLIGHT (*Cercospora apii* Fr.). Abundant in the celery-growing districts throughout the state.

LATE BLIGHT (*Septoria petroselini* Desm. var. *apii* Br. & Car.). Abundant in the celery-growing districts throughout the state.

ROOT ROT (*Sclerotinia libertiana* Fckl.). Occasional, sometimes severe.

CROWN AND HEART ROTS (*Bacterial*). Very severe in some localities (page 461).

Cherry

BROWN ROT (*Sclerotinia cinera* (Bon) Schrot.). Abundant and very destructive.

LEAF SPOT (*Cylindrosporium padi* Karst.). Abundant and destructive.

LOW TEMPERATURE in early spring, resulting in leaf fall later in the season.

Chestnut

BLIGHT (*Diaporthe parasitica* Murrill). Abundant.

Clover, Red

Rust (*Uromyces trifolii* (Hedw.) Lev.). Common but of no importance.

Corn

Smut (*Ustilago zeæ* (Beckm.) Urg.). Very common and in some cases serious.

Wilt (*Fusarium* (?)). Widely distributed throughout the state. It is the subject of special study.

Wilt (*Pseudomonas stewarti* E. F. Smith). Occasional in northern part of state. Of no importance.

Rust (*Puccinia sorghii* Schw.). Occasional but of no importance.

Leaf Blotch (*Helminthosporium inconspicuum* C. & E.). Common.

Cowpea

Leaf Spot (*Cercospora dolichii* E. & E.). Common.

Cranberry

Scald (*Guignardia vaccinii* Shear). Widely distributed and very abundant in the cranberry bogs of the state.

Rot (*Acanthorynchus vaccinii* Shear). More or less common.

Anthracnose (*Glomerella rufomaculans vaccinii* Shear). *Glœosporium* stage common.

Cucumbers

Leaf Spot (*Macrosporium cucumerinum* C. & E.). Common and destructive.

Downy Mildew (*Plasmopara cubensis* (B. & C.) Humphrey). Common and destructive.

Wilt (*Bacillus tracheiphilus* (E. F. Smith). Very common.

Stem Rot (*Sclerotinia libertiana* Fckl.). Common on plants grown under glass.

Currant

Anthracnose (*Glœosporium ribis* (Lib.) M. & D.). Very common.

Leaf Spot (*Septoria ribis* Desm.). Common.

Cane Blight (*Botryosphæria ribis* G. & D.). Common and very destructive.

Rust (*Cronartium ribicola* Kleb.). Reported from two localities.

Dewberry

Anthracnose (*Glœosporium venetum* Speg.). Common and sometimes severe.

Double Blossom (*Fusarium rubi* Wint.). Abundant and sometimes injurious.

Rust (*Gymnoconia interstialis* (Howe) Franz.). Common and sometimes destructive.

Leaf Spot (*Septoria rubi* West.). Very abundant but of little importance.

Eggplant

Leaf Blight (*Phomopsis vexans* (Sacc. & Syd.) Harter). Abundant and in some cases destructive.

Wilt (*Verticillium albo-atrum* R. & B.). Common and destructive throughout the state (page 469).

Gooseberry

ANTHRACNOSE (*Pseudopeziza ribis* Kleb.). *Glœosporium* stage common.
LEAF SPOT (*Septoria ribis* Desm.). Common.

Grape

BLACK ROT (*Guignardia bidwellii* (Ell.) V. & R.). Abundant and severe.
DOWNY MILDEW (*Plasmopara viticola* (B. & C.) D. T.). Common but not serious.
NECROSIS (*Fusicoccum viticolum* Reddick). Rare.
CHLOROSIS. Caused the loss of several plants in one locality (Glassboro). Cause undetermined.

Hollyhock

RUST (*Puccinia malvacearum* Mont.). Very common.

Horse Chestnut

LEAF SPOT (*Guignardia æsculi* Stewart). Very common.

Horse-Radish

Rot (Bacterial). Very common and very destructive in one locality (page 464).
ROOT ROT (*Thielavia basicola* B. & Br.) Common and sometimes destructive.

Lettuce

DROP (*Sclerotinia libertiana* Fckl.). Common and sometimes destructive.

Lilac

MILDEW (*Microsphæra alni* (Walls.) Wint.). Very common.
LEAF SPOT (*Phyllosticta halstedii* Ell.). Common.

Maple

TAR SPOT (*Rhytisma acerinum* (Pers.) Fr.). Occasional.
LEAF INJURIES (cold weather). Many complaints came in during the spring of 1921 concerning leaf injuries which were no doubt due to frost and unfavorable weather conditions.

Muskmelon

WILT (*Bacillus, tracheiplitis* E. F. Smith). Common and sometimes destructive.
DOWNY MILDEW (*Plasmopara cubensis* (B. & C.) Humphrey). Common and sometimes severe.
LEAF MOLD (*Alternaria brassicæ* (Berk.) Sacc.). Common and severe.

Oats

SMUT (*Ustilago levis* (K. & S.) Magnus). Common.
SMUT (*Ustilago avenæ* (Pers.) Jens.). Common.
RUST (*Puccinia coronata* Cda.). Common.

Okra

WILT (*Verticillium albo-atrum* R. & B.). Abundant in one locality.

Pea

LEAF SPOT (*Ascochyta pisi* Lib.). Occasional.

ROOT ROT (*Fusarium* sp.). Very abundant and very destructive. Heaviest losses in Burlington and Cape May counties.

Peach

BROWN ROT (*Sclerotinia cinerea* (Bon.) Schrot.). Abundant and destructive.

SCAB (*Cladosporium carpophilum* Thum.). Abundant in unsprayed orchards.

LEAF CURL (*Exoascus deformans* (Berk.) Fckl.). Abundant in orchards that have not been properly sprayed.

SHOT-HOLE (*Bacterium pruni* E. F. Smith). Abundant in some localities.

MILDEW (*Podosphæria oxycanthæ* (D. C.) DeBary). One case on the fruit in May, 1921.

YELLOWS. Common.

LITTLE PEACH. Common.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Common.

WINTER INJURY. In some cases severe and dating back to 1917-18.

Pear

FIRE BLIGHT (*Bacillus amylovorus* (Burr.) DeToni). Common throughout the state and severe in a few orchards.

LEAF AND FRUIT SPOT (*Fabræa maculata* Lev.). Very abundant and very destructive in some orchards, especially in the southern part of the state.

LEAF SPOT (*Septoria pyricola* Desm.). Abundant.

BROWN BLOTCH (Cause undetermined). Common.

SCAB (*Venturia pyrina* Aderh.). Common where the orchards have been neglected.

Pepper

ANTHRACNOSE (*Colletotrichum nigrum* E. & H.). Common.

ROT (*Macrosporium* sp.). Common on fruits, especially those that have been sunburned.

MOSAIC. Common but apparently of little importance.

SUN SCALD. Common and followed by fruit rots.

LEAF FALL (Cause unknown). Cause of heavy losses.

Pine

BLISTER RUST of white pine.

Plum

BLACK KNOT (*Plowrightia morbosa* (Schw.) Thum.). Common throughout the state.

BROWN ROT (*Sclerotinia cinerea* (Bon.) Schrot.). Common throughout the state and destructive.

Potato

BROWN STEM (*Rhizoctonia*). Common but not as destructive as in previous years.

BLACK LEG (*Bacillus phytopthorus* Appel). Rare in 1920; common in 1921.

SCAB (*Actinomyces chromogenus* Gast.). Much more abundant than usual.

EARLY BLIGHT (*Alternaria solani* (E. & M.) S. & G.). Abundant throughout the state.

LATE BLIGHT (*Phytophthora infestans* DeBary). Very abundant and very destructive.

MOSAIC. Very severe in some fields of Giants.

LEAF ROLL. Rare.

TIP BURN. Common.

ARSENICAL POISONING. Common and usually due to carelessness in application.

SEED PIECE ROT (*Bacillus vulgarus*). Prevalent in some parts of the state during spring of 1921.

SPINDLING SPROUTS. Common. Probably due to several causes.

Quince

BLACK ROT (*Sphæropsis malorum* Pk.). Very abundant and very severe.

FIRE BLIGHT (*Bacillus amylovorus* (Burr) De'Toni). Common.

LEAF AND FRUIT SPOT (*Fabræa maculata* (Lev.) Atk.). Abundant and very severe.

RUST (*Rostellia aurentiana* Pk.). Occasional.

Raspberry

ANTHRACNOSE (*Glœosporium venetum* Speg.). Abundant and destructive.

LEAF SPOT (*Septoria rubi* West.). Abundant but of little importance.

CANE BLIGHT (*Leptosphæria coniothyrium* Fckl.). Common and sometimes destructive.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Abundant and destructive.

Rose

ANTHRACNOSE (*Glœosporium rosæ* Hals.). Common but not serious.

LEAF BLOTCH (*Actinonema rosæ* (Lib.) Fr.). Common and very severe in greenhouses.

LEAF SPOT (*Phllostiata rosicola* Massal.). Abundant and sometimes confused with leaf blotch.

CANE BLIGHT (*Leptosphæria coniothyrium* (Sacc.) Fckl.). Common and sometimes serious.

POWDERY MILDEW (*Sphærotheca pannosa* (Wallr.) Lev.). Common and frequently very injurious.

CROWN GALL (*Bacillus tumefaciens* S. & T.). Frequent and sometimes serious.

ROSE (*Botrytis* sp.). Causing a rotting of buds in the greenhouse.

Strawberry

LEAF SPOT (*Mycosphærella fragariæ* (Tul.) Lidau). Common.

LEAF SPOT (*Ramularia tulasnei* Sacc.). Common.

WINTER INJURY. Occasional.

Sun-Flower

Rust (*Puccinia helianthii* Schw.). Occasional.

Sweet Potato

Black Rot (*Sphæronema fimbriatum* (E. & H.) Sacc.). Abundant.
Stem Rot or Yellow Rot (*Fusarium batatatis* Wollen. and *E. Hyperoxysporium*). Abundant and the cause of heavy losses (page 466).
Scurf (*Monilochætes infuscans* E. & H.). Very common.
Rots (*Rhizopus nigricans* Ejr., *Diaporthe Batatatis* H. & F., *Sclerotium bataticola* Taub, *Tricoderma kœnigii* and *Penicillium* sp.). Very abundant, especially in storage.
Pox (*Cytospora batata* Elliott). Occasional.
Seed-Bed Rot (*Fusarium* sp.). Occasional.

Sycamore

Anthracnose (*Gnomonia veneta* (S. & S.) Kleb.). Very common; sometimes destructive in nurseries.
Sun Scald. Several well defined cases. In some cases the trees died.

Tomatoes

Leaf Blight (*Septoria lycopersici* Speg.). Abundant and very destructive (page 463).
Fruit Rot (*Macrosporium solani* E. & M.). Common and very destructive.
Anthracnose (*Colletotrichum phomoides* (Sacc.) Chester). Abundant and very destructive.
Stem Blight or Wilt (*Fusarium lycopersici* Sacc.). Abundant in one locality.
Streak (Cause unknown). Very abundant in some fields in 1921.
Mosaic Abundant.
Leaf Mold (*Cladosporium fulvum* Ck.). Common in greenhouses and very severe.
Leaf Roll (Cause unknown). Common and apparently becoming more serious.

Walnut

Leaf Spot (*Marsonia juglandis* (Lib.) Sacc.). Abundant and cause of early fall of foliage.
Bacterial Spot of Leaf and Fruit (*Pseudomonas juglandis* Pierce). Abundant on English walnuts and the cause of many inquiries.

Watermelons

Anthracnose (*Colletotrichum lagenarium* (Passe.) E. & H.). Very abundant.

Wheat

Rust (*Puccinia coronata* Cda.). Common.
Rust (*Puccinia rubigovera* (De C.) Wint.). Common.
Rust (*Puccinia triticinia* Erh.). Common.
Smut (*Tilletia fœtens* (B. & C.) Trel.). Common.
Smut (*Tilletia tritici* (Bei.) Wint.). Common.
Smut (*Ustilago tritici* (Pers.) Jens.). Common.
Mold (*Cladosporium herbarium* (Pers.) Lk.). Abundant.
Scab (*Gibberella saubinetti* (Mont.) Sacc.). Very common and destructive.

REPORT OF POTATO-SPRAYING TESTS

WILLIAM H. MARTIN

The cooperative potato-spraying tests were continued during the summer of 1920. In addition to the regular spray schedule a comparison was made of various strengths of Bordeaux mixture and the value of early and late applications of the standard 5-5-50 mixture.

Comparison of Various Strengths of Bordeaux Mixture

The soil on which this test was conducted is a Sassafras loam to sandy loam in excellent condition and well adapted to potatoes. The field was planted with home-grown Irish Cobblers. At the time of planting, 1 ton of a 4-8-3 fertilizer was applied per acre.

The purpose of this test was to compare the value of various amounts of copper for the control of tip-burn and early blight. The standard 5-5-50 mixture was compared with a 4-4-50 mixture. In both cases the sprays were applied at the rate of 100 gallons per acre. The sprayer used for this work was a traction machine, and a uniform pressure of 150 pounds was maintained for all of the work. The machine was equipped to spray 4 rows. Three nozzles were used to the row, one nozzle was directed downward while the other two were pointed inward, which plan gives a very good covering.

Five spray applications in all were made on the following dates. The first application was made on June 8 when the plants were 6 inches high. The second, third and fourth applications were made June 18 and 29, and July 9, respectively. Up until this time no foliage diseases of any kind had appeared on either the Bordeaux or the check plots. At the time of the fifth application, July 22, the plots receiving the copper sprays were still green, while the check plots were heavily infected with tip-burn and early blight. In this test the check plots were sprayed with arsenate of lead at the rate of 6 pounds of the powder per acre. In this connection the question might be raised as to whether this does not explain the relatively small increases resulting from previous spraying tests with Bordeaux mixture in New Jersey. There is little doubt but that if the check plots received the treatment given the general fields by a majority of the growers a greater difference would be observed between the so-called check plots and the treated plots. In most instances the New Jersey growers use an arsenate of lead or paris green dust for the control of insects; where the liquid is applied the pressure is usually very low and the machine is frequently equipped with but one nozzle to the row. As will be shown later in this report, thorough spraying with arsenate of lead can be expected to give an increase in yield over dusted plants and probably over those poorly sprayed.

In table 1 is given the arrangement of the plots together with the yield per acre for each plot. The last column of the table gives the number of dead leaves on the various plots on August 3. These data were obtained by making a count of the number of dead leaves on every tenth plant on the middle row of each plot.

The average yield of the plots sprayed with arsenate of lead is 260.3 bushels per acre as compared with 281.4 bushels and 266 bushels for the plots receiving the 5-5-50 and the 4-4-50 mixtures, respectively. On the basis of dead leaves from the count made August 3 there was also a difference in favor of the 5-5-50 mixture. The average number of dead leaves on the check plots was 93.3 per cent as compared with 70.3 per cent on the 5-5-50 plots and 76.3 per cent on the 4-4-50 plots.

Table 1

Comparison of Different Strengths of Bordeaux Mixture—Irish Cobbler Variety of Potatoes

TREATMENT	Total Yield per Acre	Calculated Yield per Acre of Checks	Difference	Dead Leaves on August 3
	bu.	bu.	bu.	per cent
Check—Arsenate of lead	279.5	.....	.....	92
Bordeaux mixture—5-5-50 and arsenate of lead	283.4	269.2	+14.2	76
Bordeaux mixture—4-4-50 and arsenate of lead	270.6	260.2	+10.4	76
Check—Arsenate of lead	250.6	.....	.....	93
Bordeaux mixture—5-5-50 and arsenate of lead	273.9	255.2	+18.7	68
Bordeaux mixture—4-4-50 and arsenate of lead	260.9	259.8	+ 1.1	77
Check—Arsenate of lead	264.6	.....	.....	93
Bordeaux mixture—5-5-50 and arsenate of lead	288.2	259.1	+29.1	67
Bordeaux mixture—4-4-50 and arsenate of lead	266.6	252.8	+13.8	76
Check—Arsenate of lead	246.5	.....	.....	98

These results were obtained in the absence of late blight; the increased yield as the result of spraying no doubt resulting from the control of tip-burn and early blight. Tip-burn was abundant and the difference in appearance between the plots sprayed with Bordeaux mixture and of those sprayed with arsenate of lead was greater than is indicated by the count of dead leaves.

From the results of this test, it is apparent that the use of 5-5-50 Bordeaux mixture can be expected to give better control of tip-burn and early blight than the 4-4-50 mixture.

Comparison of Early and Late Spray Applications

In the same field in which the work just reported was conducted a comparison was made of the relative value of early and late applications of Bordeaux mixture for the control of tip-burn and early blight.

The plots receiving the early applications were sprayed on June 8, 18 and 29, and those receiving the late applications on June 29 and July 9 and 22. The check plots were sprayed with arsenate of lead at the rate of 6 pounds of the powder to the acre.

The arrangement of the plots and the yield per acre are given in table 2. The average yield of the check plots was 259.4 bushels per acre, of the plots receiving the early applications 240.3 bushels per acre, and of those receiving the late applications 273.1 bushels per acre. It is apparent that the plots receiving the early applications showed a decrease of 19.1 bushels over the check plots, while those receiving the late applications showed an increase of 13.7 bushels.

As in the previous test a count of the dead leaves was made on August 3. At that time 98 per cent of the leaves on the check plots were dead, on the plots receiving the early applications 91 per cent of the leaves were dead, while on the plots receiving the late applications 75 per cent were dead.

It is interesting to compare the yield of these plots with that of the plots in the same field receiving 5 applications. The average yield of the check plots for these two tests was 260.3 bushels and 259.4 bushels, per acre, indicating that there was little difference in the soil in various parts of the field. The average yield of the plots sprayed five times with Bordeaux mixture was 281.4 bushels per acre, for those receiving the three late applications, 273.1 bushels and for those receiving the early applications 240.3 bushels per acre.

Table 2

Yield of Potatoes per Acre in Comparison of Early and Late Spray Applications, Irish Cobbler Variety

TREATMENT	Series A	Series B	Series C	Average
	bu.	bu.	bu.	bu.
Check—Arsenate of lead	242.3	249.2	245.6	245.7
Bordeaux mixture and arsenate of lead, June 8, 18, 29.....	241.3	239.3	240.4	240.3
Bordeaux mixture and arsenate of lead, June 29, July 9.....	305.4	278.3	268.4	284.0
Check—Arsenate of lead	290.3	272.9	256.3	273.1

The results of this test indicate the importance of the late applications. The superiority of the late applications no doubt arose from the fact that in this test no early blight appeared until late in the season. The early applications were no doubt washed from the leaves before the disease became prevalent, and consequently afforded little protection. On the other hand, the late applications covered the leaves with a protective film of the copper spray at a time when needed for the protection of the plant. The difference in yield between the plots sprayed three times late in the season and those sprayed five times would indicate further that it may not be essential that the early applications be made. This would lead to a considerable reduction in spraying cost, but must be the subject of further study before definite recommendations can be made.

Table 3

Arrangement of Plots and Yield per Acre of Spraying Tests with Late-Crop Irish Cobblers

TREATMENT	Total Yield per Acre	Calculated Yield per Acre of Check	Difference	Dead Leaves on October 18
	bu.	bu.	bu.	per cent
Check	166.6	.....	.....	90
Bordeaux mixture 5-5-50	202.6	165.4	37.2	15
Arsenate of lead	172.2	164.2	8.0	75
Check	163.0	.....	.....	95
Bordeaux mixture 5-5-50	193.0	162.7	30.3	5
Arsenate of lead	178.2	162.5	15.7	70
Check	162.3	.....	.....	95
Bordeaux mixture 5-5-50	202.3	.....	.....	7

Spraying Tests with the Late Crop

Spraying tests with the late crop were conducted with both the American Giant and the Irish Cobbler varieties. In previous spraying tests with the former variety, planted in the spring, conflicting results have been secured. This year a spraying test was conducted with this variety grown late for seed purposes to determine if positive results would follow. The purposes of the test was defeated, however, in that late blight made its appearance, thus ensuring the success of the spray treatment.

Irish Cobbler Variety

The soil on which this test was conducted is a Sassafras loam in good condition. One ton of a 4-8-3 fertilizer was applied at time of planting. There were 15 plots in all, a check plot alternating between each two treated plots. As a result of the fact that there were no insects present in the field, the check plots were left without any kind of spray treatment.

The spray mixtures used were the standard 5-5-50 Bordeaux applied at the rate of 100 gallons per acre and arsenate of lead used at the rate of 6 pounds per acre. The latter material was included in the test to determine if thorough spraying with arsenate of lead would lead to increased yields over plots that had not been sprayed.

Five spray applications were made in all on the following dates, September 8, 12 and 27, and October 7 and 18. The last of September late blight was found on the unsprayed plots and by October 18 most of the leaves were dead. At that time a count was made of the number of dead leaves on each plot. On the unsprayed checks 94 per cent were dead as compared with 27 per cent on the plots sprayed with Bordeaux mixture, and 68 per cent on those sprayed with arsenate of lead.

The arrangement of the plots as well as the yield per acre is given in table 3. Unfortunately the third repeat of the arsenate of lead treatment and the last check plot was harvested before the weights could be obtained. The average yield of the unsprayed plots was 163.9 bushels per acre, of the arsenate of lead plots 175.2 bushels, and of the Bordeaux plots 199.3 bushels per acre. It will be seen that the arsenate of lead plots showed an increase of 11.3 bushels per acre over the unsprayed plots.

American Giant Variety

This test was conducted in the same field as was the one with the Irish Cobbler variety. The spray mixture used was the standard 5-5-50 Bordeaux mixture applied at the rate of 100 gallons per acre. The number of applications and the dates on which they were made were the same as for the Irish Cobbler variety.

Early in October late blight was responsible for killing the leaves. On October 18 a count was made of the number of dead leaves on each plot. On the unsprayed check plots 62 per cent were dead as compared with 12 per cent on the plots sprayed with Bordeaux mixture. The average yield of the check plots was 150.4 bushels per acre as compared with 178 bushels for the plots sprayed with Bordeaux mixture (table 4).

Table 4

Arrangement of Plots and Yield per Acre of Spraying Test with the Late Crop (American Giant Variety)

TREATMENT	Total Yield per Acre	Rotted Tubers at Time of Digging	Yield of Sound Tubers	Calculated Yield per Acre of Checks	Difference
	bu.	bu.	bu.	bu.	bu.
Check	163.0	2.4	161.6	.....	....
Bordeaux mixture 5-5-50..	184.0	.....	184.0	156.7	27.3
Bordeaux mixture 5-5-50..	199.4	.....	199.4	151.8	47.6
Check	153.1	6.2	146.9	.....	....
Bordeaux mixture 5-5-50..	166.9	.....	166.9	141.5	25.4
Bordeaux mixture 5-5-50..	161.7	.....	161.7	136.1	25.6
Check	135.3	4.6	130.7	.....	....

THE INFLUENCE OF SULFUR ON THE CONTROL OF POTATO SCAB

WILLIAM H. MARTIN

The studies resumed last year on the relation of sulfur to the control of common scab of potatoes have been continued. Experiments were conducted in the important potato-growing sections of the state on different soil types and with both American Giant and Irish Cobblers varieties. In all of the tests conducted the sulfur applications were made broadcast just before the crop was planted. The applications were made by hand or with a grain drill. The latter method proved more efficient, since a uniform distribution is assured and the sulfur is thoroughly worked into the soil.

In the experiments conducted no differences were apparent in vine growth on the plots receiving various amounts of sulfur. When the crop was harvested it was divided into three classes, namely, clean, salable and unsalable scabby. The first class consisted of all tubers free from scab. The tubers in the second class showed only a moderate infection, while those in the last class were for most part covered with scab lesions.

Soil samples were taken at the time of planting and again when the crop was harvested. The hydrogen-ion concentration of water extracts of the soil samples was determined colorometrically following the method devised by Gillespie (2). The indicators used were those recommended by Clark and Lubs (1).

This work will be reported briefly here; a more complete discussion of the results will appear in another place. The following tables show the yield per acre as well as the relation of clean, salable and unsalable scabby tubers to the hydrogen-ion exponent. The data given are averages obtained from at least three replications of each treatment and of four checks plots.

Irish Cobbler Variety

Experiment 1

The soil on which this experiment was conducted is a very light sandy loam. In 1919 the field was planted with the Red Skin variety of potatoes. At that time the entire crop was very scabby, a greater part of the tubers being unsalable. Sulfur applications at the rate of 300 and 600 pounds per acre were made on April 27, just before planting. The effect of the sulfur treatment on total yield and control of scab is shown in table 1.

Table 1

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(I. Kaufmann farm, Bridgeton)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	97.3	20.1	40.8	38.5	6.05
300 lbs. Sulfur† ...	88.2	54.1	24.5	21.4	5.50
600 lbs. Sulfur† ...	87.2	75.0	20.8	4.2	4.75

*Average of 6 plots.
†Average of 3 plots.

It will be seen from the table that the 300 and 600-pound applications show a decrease in yield of 9.1 and 10.1 bushels per acre over the adjoining check plots. It will also be seen that there was a marked gain in the number of clean tubers on the treated plots, this increase amounting to 34 and 54.9 per cent for the 300 and 600-pound applications, respectively. On the basis of unsalable scabby tubers there was a considerable decrease on the sulfured plots, the decrease being greater with the heavier applications. With the decrease in the number of unsalable scabby tubers there was a corresponding decrease in the exponent values of the soil extracts from the treated plots. At the time of planting the exponent value of the check plots was 6.3 as compared with 6.05 at the time of harvesting. The exponents of the plots receiving the 300 and 600-pound applications were 5.50 and 4.75, respectively.

Experiment 2

The soil on which this experiment was conducted is a Sassafras to sandy loam. This field was limed in 1916. Since then it has been in corn in 1916, potatoes in 1917 and 1918 and corn in 1919. In 1918 the potato crop was very scabby, approximately 30 per cent of the crop being unsalable.

Sulfur flour was applied at the rate of 300 and 600 pounds per acre just before planting. Soil samples taken from the various plots before the sulfur applications were made showed an average hydrogen-ion exponent of 6.6.

Table 2

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Alfred Sloan farm, Elmer)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	254.0	61.2	38.8	....	5.96
300 lbs. Sulfur†...	238.8	92.3	7.7	....	4.85
600 lbs. Sulfur†...	258.9	92.2	7.8	....	4.56

*Average of 6 plots.
†Average of 3 plots.

The results of this experiment are given in table 2. On the basis of total yield the plots receiving 300 pounds of sulfur per acre show an apparent decrease of 15.2 bushels over the untreated plots, while those receiving the 600-pound application show an increase of 4.9 bushels.

In this experiment there were no unsalable scabby potatoes. There was, however, a marked increase in the number of clean tubers on the plots receiving the sulfur applications, this increase being slightly greater for the plots receiving the 300-pound application. There is little difference in exponent values between the treated plots; 4.85 and 4.56 for the 300 and 600-pound applications, respectively. It is apparent from the results obtained that for this soil it was unnecessary to use sulfur in excess of 300 pounds to obtain satisfactory control of scab.

Experiment 3

The soil on which this test was conducted is a sandy loam. The field received an application of lime in 1913 at the rate of 1½ ton of calcium oxide per acre. It was last planted in potatoes in 1917 and at that time there was a severe infestation of scab over the entire field. Sulfur was applied at the rate of 300 and 600 pounds per acre just before planting.

Table 3

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Isaac Bacon farm, Salem)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	287.3	23.5	32.7	43.8	6.15
300 lbs. per acre† ..	291.3	64.8	17.4	17.8	6.1
600 lbs. per acre† ..	328.3	68.0	20.1	11.9	4.8

*Average of 6 plots.
†Average of 3 plots.

The results of this test are given in table 3. It will be seen that both the 300 and 600-pound applications gave increased yields over the check plots. As in the preceding experiments there was a considerable increase in the number of clean tubers with a corresponding decrease in the unsalable scabby tubers on the treated plots.

The initial hydrogen-ion exponent of this soil was 6.4 as compared with 6.15 for the check plots at the time of digging. It will be observed that a marked decrease in exponent values resulted on the plots treated with 600 pounds of sulfur, while the decrease on the plots receiving 300 pounds was very slight. It has been previously shown (3) that the hydrogen-ion exponent values reach their lowest level about mid-season and then tend to return to the original values at digging time. This may possibly account for the fact that while there is no apparent lowering of exponent values on the plots receiving the 300-pound application the control of scab is approximately as efficient as on the plots treated with 600 pounds of sulfur.

Experiments with the American Giant Variety

In the past the New Jersey growers have frequently resorted to growing the American Giant variety, resulting from the fact that they were considered less likely to scab than the Irish Cobbler variety. It is doubtful if this is longer true, since many fields were observed

the past several years in which the American Giant variety grew very scabby. A number of experiments were conducted with this variety this year.

Experiment 1

The field in which this work was conducted received an application of 1,700 pounds of ground limestone per acre in 1913. It was last in potatoes in 1915. At that time there was a uniform scab infection over the entire field, approximately 30 per cent of the crop being unsalable. Sulfur was applied at the rate of 300 and 600 pounds per acre just before planting.

Table 4

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Wm. Patterson farm, Freehold)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	308.8	39.9	47.9	12.2	6.22
300 lbs. Sulfur†...	269.7	76.9	16.5	6.6	5.86
600 lbs. Sulfur†...	316.8	90.3	9.4	0.3	4.8

*Average of 6 plots.
†Average of 4 plots.

The results of the test are given in table 4. On the basis of total yield the plots receiving the 600-pound application showed an increase of 8.0 bushels per acre over the check plots, while those receiving 300 pounds showed a decrease of 39.1 bushels. In view of the fact that the 600-pound application resulted in a slight increase it is questionable if the decrease resulting from the 300-pound application can be attributed to any injurious effect of the sulfur treatment.

Of the total yield from the untreated plots 60.1 per cent were scabby, while the plots treated with 300 pounds of sulfur and those receiving 600 pounds gave total yields of which only 23.1 per cent and 9.7 per cent, respectively, were scabby. The initial exponent of this soil was 6.4 as compared with an exponent of 6.2 at time of

digging. It will be seen that with increased applications of sulfur there were corresponding decreases in exponent values, amounting to 0.36 for the 300, and 1.42 for the 600-pound treatment.

Experiment II

This field received 2,000 pounds of hydrated lime per acre in 1916. It was last in potatoes in 1918 and 1919. At that time, while there was considerable scab, the infestation was not uniform. Sulfur applications were made at the rate of 300 and 600 pounds per acre. The results are given in table 5.

Table 5

Influence of Sulfur Applications on Total Yield and Percentage of Scabby Tubers

(I. Van Deveer farm, Freehold)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby
	bu.	per cent	per cent	per cent
Check*	330.5	44.4	52.4	3.2
300 lbs. Sulfur†	311.6	73.9	23.2	2.9
600 lbs. Sulfur†	350.8	76.8	22.1	1.1

*Average of 4 plots.
†Average of 2 plots.

In this field the plots receiving both the 300 and the 600-pound treatment outyielded the adjoining untreated plots. While the number of clean tubers is increased on the treated plots as compared with the checks, with a corresponding decrease in the number of unsalable tubers, the differences are by no means as great as recorded for the first experiment with this variety. This may possibly be accounted for by the fact that the decrease in exponent values is not as great in this as in the other experiment, being only 0.2 and 0.4 for the 300 and 600-pound applications, respectively. This slight decrease in exponent values might be accounted for by the fact that the sulfur was not oxidized due to the absence of sulfur-oxidizing organisms. The importance of their presence to insure success following the use of sulfur for the control of scab will be discussed at another place in this report.

Experiment 3

This field received an application of lime in 1902 and a heavy application of marl in 1904. It was last planted in potatoes in 1917. At that time there was a uniform infestation of scab on the portion of the field treated with marl. Sulfur was applied at the rate of 300 and 600 pounds per acre. The results are given in tables 6.

Table 6

Influence of Sulfur Applications on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(Britton Cook farm, Farmingdale)

Treatment	Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	159.8	12.0	57.8	30.2	6.3
300 lbs. Sulfur†...	182.0	34.6	46.8	18.6	6.1
600 lbs. Sulfur†...	170.2	40.8	45.5	13.7	5.9

*Average of 6 plots.
†Average of 4 plots.

The plots receiving the light application of sulfur showed a decrease of 18.9 bushels per acre, while the 600-pound treatment showed an increase of 20.3 bushels over the check plots. The number of clean tubers was increased from 44.4 per cent on the untreated plots to 73.9 per cent on the plots receiving 300 pounds of sulfur, and 76.8 per cent on those receiving 600 pounds. There was a corresponding decrease in the number of scabby tubers.

References

(1) Clark, W. A., and Lubs, H. A., 1917. The colorimetric determination of hydrogen-ion concentration and its application to bacteriology. *In* Jour. Bact., v. 2, no. 1., p. 1-34; v. 2, no. 1, p. 109-136; v. 2, no. 3, p. 191-235.

(2) Gillespie, L. J., 1920. Colorimetric determination of hydrogen-ion concentration without buffer mixtures, with especial reference to soils. *In* Soil Sci., v. 9., no. 2, p. 115-136.

(3) Martin, Wm. M. H., 1921. A comparison of inoculated and uninoculated sulfur for the control of potato scab. *In* Soil Sci., v. II, no. 1, p. 75-84.

INOCULATED VS. UNINOCULATED SULFUR FOR THE CONTROL OF POTATO SCAB

WILLIAM H. MARTIN

It will be seen from the preceding paper that while the use of commercial sulfur flour in most of the tests conducted gave very good control of scab, in others the differences in the number of salable potatoes on the treated and untreated plots was not so marked. It has been demonstrated that the biological factor is influential in the oxidation of sulfur. In view of the fact that the beneficial action from the use of sulfur results from its oxidation, the importance of the presence of sulfur-oxidizing organisms is readily apparent. It is very probable that the lack of these organisms in the soil might determine to a large extent the success or failure of sulfur to control scab. The experiments herein reported were conducted to determine to what extent this might be true.

In this work inoculated and uninoculated commercial sulfur flour were used. Inoculation was effected by means of a thorough mixing of the commercial flour with 1 per cent of soil from a compost heap known to be well supplied with the sulfur oxidizing organism. The sulfur applications were made with a grain drill just after harrowing and just before planting. The experiments were conducted with the Irish Cobbler variety. At the time of harvesting, soil samples were taken and the crop divided into classes as previously outlined.

The results of the test are given in the following tables. The data included in the tables show the yield per acre as well as the relation of clean, salable and unsalable scabby tubers to the hydrogen-ion exponent.

Experiment 1

The soil on which this experiment was conducted is a Sassafras loam. In 1915 an application of ground limestone was made at the rate of 3 tons per acre. Following this treatment the field was in grass in 1916 and 1917, and in potatoes in 1918 and 1919. In the latter year there was a uniform infestation of scab over the entire field, a great part of the crop being unsalable.

Both inoculated and uninoculated sulfur were applied just before planting at the rate of 300 and 600 pounds per acre. It will be seen from table 1 that on the basis of total yield the treated plots showed a considerable increase over the untreated check plots.

Table 1

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(R. E. Colyer farm, Jamesburg)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check	195.0	0	6.4	93.6	7.06
600 lbs. uninoculated sulfur	229.0	10.9	37.7	51.4	6.23
600 lbs. inoculated sulfur	249.4	46.9	28.7	24.4	5.60

This increase may be accounted for in part by the fact that the tubers on the check plots were severely scabbed, none of them being free from scab lesions. On the other hand, while of those from the treated plots some were scabby, none were severely infected.

With the 600-pound applications of both the inoculated and the uninoculated sulfur there was a considerable decrease in unsalable potatoes over the adjoining check plots. This decrease amounted to 69.2 for the former and 42.2 for the latter. The benefit derived from the use of the inoculated sulfur is more clearly brought out when the number of clean tubers is considered. On the untreated plots none were clean as compared with 10.9 per cent for the plots treated with the uninoculated, and 46.9 per cent for those receiving the inoculated sulfur.

The plots receiving the inoculated sulfur showed a greater decrease in hydrogen-ion exponent values than those treated with the uninoculated sulfur. This decrease amounted to 1.45 for the former and 0.83 for the latter.

The plots treated with 300 pounds of sulfur likewise show a lower percentage of scabby tubers than the untreated plots. Of the total yield from the untreated plots, 58.3 per cent were unsalable scabby while the plots treated with inoculated and uninoculated sulfur gave a total yield of which 29.4 per cent and 57.4 per cent, respectively, were unsalable.

Table 2

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(R. E. Colyer farm, Jamesburg)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check*	183.1	9.4	32.3	58.3	6.6
300 lbs. uninoculated sulfur*	254.3	13.1	29.5	57.4	6.3
300 lbs. inoculated sulfur*	288.7	34.1	36.5	29.4	6.0

*Average of 3 plots.

From the table it will be seen that the plots receiving 300 pounds of inoculated sulfur showed greater decreases in exponent values than those receiving the uninoculated sulfur.

It is interesting to note that the decrease in exponent values indicated for the plots treated with 300 pounds of inoculated sulfur was nearly as large as for the plots treated with 600 pounds of uninoculated sulfur. The latter showed a reduction of 42 per cent in the number of unsalable scabby potatoes as compared with 28.9 per cent for the former, a difference of only 13.3 per cent in favor of the heavier applications.

Experiment 2

The soil on which this experiment was conducted is a Penn loam that had not been planted in potatoes for a number of years. To insure the presence of the scab organism in the soil untreated scabby seed was planted. Sulfur at the rate of 900 pounds per acre was broadcasted by hand just before planting. The results are given in table 3.

Table 3

Influence of Applications of Inoculated and Uninoculated Sulfur on Total Yield, Percentage of Scabby Tubers and Hydrogen-ion Concentration

(College farm, New Brunswick)

Treatment	Total Yield per Acre	Clean Tubers	Salable but Scabby	Unsalable Scabby	Hydrogen-ion Concentration
	bu.	per cent	per cent	per cent	pH
Check	78.0	43.2	34.4	22.4	6.6
900 lbs. uninoculated sulfur	60.2	69.3	15.4	15.3	4.6
900 lbs. inoculated sulfur	78.2	81.4	17.1	1.5	4.7

On the basis of total yield there was only small difference between the check and the treated plots. As in the preceding experiments there was a marked reduction of unsalable scabby tubers on the plots treated with inoculated sulfur with a much smaller reduction on the plots treated with the uninoculated sulfur. The increase in the percentage of clean potatoes was likewise greater for the inoculated sulfur, amounting to 38.2 per cent as compared with 26.1 per cent for the uninoculated sulfur.

Soil samples taken before the sulfur applications were made showed a mean value for all of the determinations of 6.61. The exponent of the check plots at time of harvesting was 6.6. The values of the hydrogen-ion exponents of the soil samples corresponding to the two treatments show a considerable decrease over those of the check plots, being 4.6 for the plots receiving the uninoculated sulfur and 4.7 for those treated with the inoculated sulfur. While the exponent values for the two treatments are approximately identical, it will be seen from the table that the number of unsalable tubers was reduced from 15.3 per cent recorded for the plots treated with uninoculated sulfur to 1.5 per cent for those receiving the inoculated sulfur.

THE FERTILIZER VALUE OF SULFUR FOR POTATOES

WILLIAM H. MARTIN

Conflicting results have been secured in the field regarding the effect of sulfur applications on the yield of potatoes. In some of the tests, plots receiving as many as 600 pounds of sulfur per acre showed marked increases over adjoining untreated check plots. In other cases an application of 300 pounds per acre resulted in decreased yields. In order that more definite information might be had on this question, experiments were conducted in the greenhouse during the winter of 1919-20. The original plan of this work was to study the effect of sulfur treatments on both scab control and yield. The soil on which the work was conducted proved too acid, however, to allow for the development of the scab organism. For this reason the experiment was limited to a test of the effect on yield.

In this work two methods of applying the sulfur were adopted. In one case it was broadcasted and thoroughly worked into the surface soil just before planting. Three amounts were applied in this manner, namely, 200, 400 and 600 pounds per acre. The second method consisted of mixing sulfur with the fertilizer. Applications were made at the rate of 100, 200 and 300 pounds per acre.

The floor of the greenhouse in which this work was conducted was divided by cement partitions into 28 compartments, each 3 feet deep and containing 7.5 square feet Seven series were included in the experiment. Each series consisted of a check plot with three treated plots. To eliminate, as far as possible, any differences that might arise from variation in the size of the seed-piece and in the yielding power of different tubers, each seed potato was cut into four equal pieces, the cut being made through the stem and bud end. One of the quarters was then planted in each of the four plots of a series. In case of the broadcasting method each series was repeated four times while there were three repeats of the sulfur-fertilizer mixture.

Each of the 28 plots received a uniform application of a 4-8-3 fertilizer at the rate of 1,800 pounds per acre. Half of the ammonia was derived from nitrate of soda, and the remaining half from ammonium sulfate. The phosphorus and potash were derived from phosphoric acid and muriate of potash.

The moisture content of the various plots was maintained as nearly uniform as possible. Before the sulfur applications were made and again at weekly intervals until the crop was dug, soil samples were taken and the hydrogen-ion concentration of soil extracts determined colorimetrically.

The effect of the two methods of applying the sulfur on yield and hydrogen-ion concentration is given in the tables following.

Sulfur in Combination with the Fertilizer

The effect of mixing sulfur with the fertilizer on yield and exponent values is given in table 1. It will be seen from the table that the addition of 100 pounds of sulfur to the fertilizer had no injurious effect, the yield of these plots being 3.4 bushels more than that of the check plots. The addition of 300 pounds of sulfur to the fertilizer brought about a decrease of 18.7 bushels over the check plots. A still greater difference, amounting to 75.3 bushels per acre, resulted from the fertilizer mixture containing 500 pounds of sulfur. It is apparent from the results secured that while a fertilizer mixture containing 100 pounds of sulfur can be used without danger of injuring the crop, any amount in excess of that can be expected to lead to a reduced yield.

Table 1

Effect of Sulfur in the Fertilizer on Yield and Hydrogen-ion Concentration

Treatment	Yield per Acre*	Hydrogen-ion Concentration		
		When Planted Dec. 2	When Dug May 4	Difference
	bu.	pH	pH	pH
Check	285.8	5.0	5.1	+0.1
100 lbs. sulfur in the fertilizer	289.2	5.1	4.8	—0.3
300 lbs. sulfur in the fertilizer	267.1	5.6	4.9	—0.7
500 lbs. sulfur in the fertilizer	213.5	5.53	4.7	—0.83

* Average of 3 plots.

From table 1 it will be seen that the original hydrogen-ion exponent values of soil samples from the various plots included in this test were low. The initial exponent value of the check plots was 5.0 as compared with 5.1 at digging time. It will be seen from the table that with increased amounts of sulfur there were corresponding decreases in the exponent values, the greatest decrease, 0.83, resulting from the use of 500 pounds of sulfur. It will be observed also that, with the exception of the 100-pound treatment, with a decrease in exponent values below that of the check plots, there was a corresponding decrease in yield.

Sulfur Broadcasted Before Planting

The effect of broadcasting sulfur on total yield and hydrogen-ion concentration is shown in table 2. It will be seen that the 200 and 300-pound applications gave slightly increased yields over the check plots. These increases, amounting to 4.2 and 1.9 bushels, are so small, however, as to be well within experimental error so that no statement can be made as to the beneficial effect of the sulfur. It is evident, however, that for the conditions under which this work was conducted an application of 200 and 400 pounds of sulfur produced no injurious effects. The yield of the plots receiving 600 pounds of sulfur, on the other hand, was 6.5 bushels less than that of the check plots.

Table 2

Effect of Sulfur Broadcasted on the Yield of Tubers and on Hydrogen-ion Concentration

Treatment	Yield per Acre	Hydrogen-ion Concentration		
		When Planted Dec. 2	When Dug May 4	Difference
	bu.	pH	pH	pH
Check	255.9	4.82	4.8	—0.02
200 lbs. sulfur broadcasted	260.1	4.65	4.6	—0.05
400 lbs. sulfur broadcasted	257.8	4.67	4.4	—0.27
600 lbs. sulfur broadcasted	249.4	5.0	4.4	—0.60

From table 2 it will be seen that the initial pH value of soil samples from the check plots was 4.82 as compared with 4.8 at the time of digging. The plots receiving the 200 and 400-pound applications showed very little change in exponent values. The largest decrease resulted from the 600-pound application. It is interesting to note in this connection that the decrease in exponent values resulting from broadcasting 600 pounds of sulfur is 0.6 as compared with a decrease of 0.7 recorded for the plots receiving 300 pounds of sulfur mixed with the fertilizer. This possibly accounts for the fact that in some of the early experiments a reduction in yield followed the use of sulfur for the control of scab. In some of these earlier tests sulfur was applied at the rate of 600 pounds per acre in the row. Applied in this way the acidity produced would be so great as to interfere with the proper development of the potato crop.

STUDIES OF THE RELATION OF MATURITY TO VIGOR IN SEED POTATOES

WILLIAM H. MARTIN

The successful potato grower of today realizes the importance of planting only vigorous seed in order that maximum yields may result. This demand on the part of the grower for high-grade seed has resulted in the establishment of seed-potato certification in many of the important seed-growing sections. The purchase of seed potatoes certified to be relatively free from disease goes a long way toward solving the problem of securing the best seed. Freedom from disease alone is not sufficient, however, to insure tubers of highest vigor. The question of maturity is one of considerable importance, since it has been frequently demonstrated that immature tubers possess more vitality than mature tubers and consequently are more desirable for seed purposes.

As early as 1849 Wilson (4) stated, "Green tubers, or tubers which have never ripened to dryness, are, in all circumstances, the best." Sweet (3) states that the remark is made of Sir Matthew Wallace, a prominent English potato grower, that, "he is without exception using partially grown or partially mature seed. The potates that are lifted in July are kept over until the next March for planting. He claims that he gets less disease than when lifted at maturity, the potato throws out a less number of sprouts when planted, it makes a more vigorous growth and the sprout is stronger. Consequently, the crop ripens earlier." The Department of Agriculture of Ireland likewise points out that "seed potatoes from crops lifted before they fully mature will produce more vigorous plants, and, consequently, heavier yields than seeds from crops which have become mature."

In a series of experiments conducted at Wye and at the Midland Agriculture College, Hutchison (1) demonstrated the advantage of immature over mature tubers for seed. He states that the superiority of immature tubers may be due to four causes; (a) the method of selection, (b) the structure of the tuber coats, (c) the amount and condition of the reserve food materials and (d) the length of the time in storage. Hutchison suggests that the best practice to follow in obtaining immature seed is to plant at the usual time of the year and raise the crop early rather than plant in the late summer or early fall.

Macoun (2) planted potatoes at 14-day intervals starting May 22, the last planting being made July 3. The tubers from the various lots were planted on the same date the following year. In most every instance there was an increase in yield from the earliest to the latest plantings, indicating that the most immature seed could be expected to give the largest yield. In another test he harvested seed immature from an early planted crop. The following year this immature seed gave pronounced increases in yield when compared with mature seed of the same variety.

In New Jersey two methods of obtaining seed potatoes are commonly followed. The first, and more important, consists in planting

not earlier than July 15 and not later than August 20. By planting at this time of the year the vines are usually growing vigorously when killed by frost, thus ensuring seed that has not matured. Among the local growers the last planted is considered the best for seed, probably resulting from the fact that this seed is more immature than seed from the earliest plantings. The second method consists of harvesting tubers immature from the main crop while the vines are still green. In the past it has not been definitely known at what stage in the development of the plant this should be done in order to obtain seed of the highest vigor. The studies here reported were undertaken with the idea of determining if possible the best time to harvest tubers from the main crop for seed purposes as well as to determine the relation between mature and immature seed with regard to vigor.

Experimental Procedure

In 1919 an area of 1/20 acre was planted with the Irish Cobbler variety to serve as a seed plot. The seed used for planting this plot was selected for uniformity and freedom from disease in 1918. The plants in the seed plot made a vigorous growth and were free from disease. At weekly intervals beginning two weeks after blossoming and continuing until the tops were dead, 15 hills were harvested. The hills harvested were selected for uniformity as to both size and appearance, especially with regard to the maturity of the vines. As each lot was harvested the weight of the individual hills was obtained. They were then placed in a well ventilated cellar until fall when they were removed to a cold-storage plant. The dates on which the various lots were dug, together with the yields per acre and the condition of the tops at the time of digging are given in table 1.

Table 1

Yield of Cobblers Dug at Intervals During the Period of Development

Date of Digging 1919	Yield per Acre	Condition of Plants
	bu.	
July 9	124.9	Two weeks after blossoming
July 17	156.5	Plants green, vigorous
July 24	207.4	24 per cent of the leaves dead
July 31	258.3	50.4 per cent of the leaves dead
August 8	281.3	91.5 per cent of leaves dead. Stems still green
August 16	280.9	Leaves and stems dead

It will be seen from the table that in a 37-day period, over which the work was conducted, there was a gain of 156 bushels per acre in total yield. The greatest weekly increases were noted for July 17-24 and for July 24-31, a gain of 50.9 bushels resulting in each of these time periods. It will be observed also that this period of greatest tuber development occurred between the time the tops began to die and when 50 per cent of the leaf surface was dead. It is interesting to note that in the time period from August 8 to August 16, that is, from the time 91.5 per cent of the leaves were dead until the stems and leaves were dead there was no increase in tuber development.

In the spring of 1920 the seed was removed from the storage house and treated for 1 hour in a solution of mercuric chloride made up at the rate of 4 ounces of the crystals to 30 gallons of water. When the seed had dried it was cut into uniform pieces, each weighing 1 ounce. In so far as possible the number of eyes was kept uniform on the various seed-pieces. The soil on which this experiment was conducted is a Penn loam. At the time of planting, April 20, an application of 1,800 pounds of a 4-8-3 fertilizer was made in the row. A plot consisted of 20 hills and to eliminate as far as possible the error arising from the use of a plot this small, each treatment was repeated six times.

While there were no marked differences in the time of germination of the various plantings, the immature tubers tended to be slightly ahead of those that were mature. As the season advanced, marked differences became apparent in the size and general vigor of the plants on the various plots.

Table 2

Height of the Vines in 1920 and Rainfall in 1919

Date Dug, 1919	Series 1	Series 2	Series 3	Series 4	Series 5	Series 6	Average	Rainfall, 1919
	in.	in.	in.	in.	in.	in.	in.	in.
July 9.....	12.5	12.7	12.9	12.9	13.3	13.0	12.9	July 2-9 1.25
July 17.....	10.1	10.5	11.8	11.0	10.8	12.6	11.1	July 10-17 1.83
July 24.....	13.0	13.2	13.4	11.7	12.8	10.6	12.4	July 18-24 5.02
July 31.....	11.7	11.9	11.9	12.0	10.9	11.2	11.6	July 25-31 0.23
August 8.....	10.7	11.1	11.2	10.0	11.1	10.9	10.8	July 31-Aug. 8 0.39
August 16.....	9.8	9.1	10.1	9.6	9.2	9.6	9.6	Aug. 9-Aug. 16 2.75

On June 14 the measurement of each plant was obtained. The average for each of the six plots is given in table 2.

It will be seen from the table that with the exception of the seed dug on July 24, 1919, there was a fairly uniform decrease in the height of the vines with increased maturity in the seed-piece. The average of the six duplications is given in the second to the last column of the table. It will be observed that the vines from the seed dug July 17 are smaller than those from seed dug a week later, the average height being 11.1 and 12.4 inches, respectively.

In this connection it is interesting to examine the precipitation records for 1919 for the time periods during which the seed was dug. These data are included in the last column of table 2. For the period July 2-9 and July 10-17 there was a rainfall of 1.25 and 1.83 inches, respectively, as compared with 5.02 inches for the period from July 18 to 24; of this amount, 3.25 inches fell the first three days. This excessive rainfall, coming at a time when tuber development was at its maximum, doubtless led to a rapid soft growth of the tuber so that the texture of the cortical layer was probably as immature as was that of the tubers dug July 9. This fact may possibly account for the differences noted in vine growth in 1920. This is in accordance with the view expressed by Hutchison (1). In explaining the superiority of immature over mature seed he states that, "the contex of immature tubers is thinner, less firmly attached and capable of being more easily ruptured than that of mature tubers. The character of the tuber coat varies with different varieties, and also in the same variety when grown under different conditions of soil and climate. Warm, dry soils favor this development and tubers grown on such land are unsuitable for seed."

These differences in the appearance of the vines of the various plots were maintained throughout the growing season.

Table 3 gives the average yield of the various plots, including primes and seconds as well as the total yields.

Table 3

Relation of Immature Seed to Yield and to Percentage of Primes

Date dug in 1919	Primes per Acre	Seconds per Acre	Total Yield per Acre	Proportion of Primes
	bu.	bu.	bu.	per cent
July 9	222.6	48.2	270.8	82.2
July 17	207.6	52.3	259.9	79.8
July 24	192.6	57.1	249.7	77.1
July 31	189.4	53.9	243.3	77.7
August 8	165.4	50.4	215.8	76.6
August 16	156.2	43.8	196.4	77.7

On the basis of total yield the greatest returns were had from the plots planted with immature seed. With each increase in maturity there was a corresponding decrease in yield, the lowest yield being recorded on those plots planted with seed that had matured before being dug. Between the most immature seed, dug July 9, and that dug August 16, when the vines had died, there was a difference of 74.4 bushels per acre. The yield of the plots from tubers dug July 24 was not as great as from those dug July 17, despite the fact that vines on the former plots were larger than those on the latter.

Except for the plots planted with the most immature seed there was little variation in the number of second-prize tubers. The former plots gave a total yield of which 82.2 per cent were primes as compared with 79.8 per cent for the seed dug July 17. Of the remaining plots those planted with seed dug July 24 and 31 showed 77.1 and 77.7 per cent, respectively.

From the results of the studies here presented it is apparent that the more immature the seed the greater will be the yield of marketable potatoes. It is questionable if the use of tubers from plants that have matured or which have died prematurely for seed purposes will give satisfactory results. In selecting tubers to be used for seed they should not only be free from disease but should be immature. Disease-free plants of low vigor cannot produce a maximum crop.

References

(1) Hutchinson, Henry P., 1916. The value of immature potato tubers as seed. *In* Jour. Bd. Agr., v. 23, no. 6, p. 529-539.
(2) Macoon, W. T., 1918. The potato in Canada. Canada Dept. Agr. Dom. Exp. Farms, Bul. 90.
(3) Sweet, Lou. D., 1916. Production of high-grade seed potatoes. *In* Mkt. Grow. Jour., v. 18, no. 2, p. 5-7.
(4) Wilson, John M. The Rural Cyclopedia, Fullarton & Co., Edinburgh.

CELERY DISEASE INVESTIGATIONS

R. F. Poole

This department has been investigating the cause and methods of control of celery root rots on muck soil areas of Bergen County for a number of years. Losses, due to *Bacillus carotovorus, Sclerotinia libertiana,* and nematodes have been very severe, especially when infected soil was cropped with Golden Self-Blanching varieties of celery. The heaviest losses occur under high temperature and moisture conditions, which are favorable for the development of these organisms. Green varieties are not severely attacked by *Bacillus carotovorus.* All varieties are susceptible to *Sclerotinia libertiana.*

Two methods of controlling root-rot diseases have been pursued in the field: application of chemical compounds as soil disinfectants and selecting for disease-resistant Golden Self-Blanching celery varieties. High-priced chemicals in the past few years made it necessary to discontinue the former part of our investigations. A very good supply of celery seed was produced last year from plants, which seemed to be resistant to *Bacillus carotovorus.* The plants were transplanted in the greenhouse from a muck farm. The seed is being tested this year on the infected muck soils.

Damping-off of seedling celery plants of all varieties in greenhouses has caused heavy losses, where plants were being grown for April and May plantings. This trouble is due to the well known fungus, *Sclerotinia libertiana,* which causes lettuce drop and damping-off of many other vegetables and plants. Rotating celery and lettuce has spread this fungus on cultivated areas. The temperature and moisture conditions of greenhouses are ideal during early spring for the development of this fungus. Several thousand plants are sometimes destroyed in a few days. The disease is first observed as a wet, soft rot near the ground. The plants later fall over, and a flocculent white mass of the fungus will appear on the leaves which fall next to the ground. This white growth produces the *sclerotia,* which are small, hard black bodies that remain in the soil until next spring and give rise to a new crop of the fungus.

For the control of this disease some very good results have been obtained by sterilizing infected muck soil in greenhouse beds with formaldehyde. Table 1 gives the results of work done this spring.

Table 1

Effect of Formaldehyde as a Control for Damping-Off of Celery

No.	Formalin	Water	Control
	pts.	gals.	
1	3	25	Poor
2	4	25	Poor
3	6	25	Poor
4	3	50	Complete
5	4	50	Complete
6	6	50	Complete

This sterilization was done in a greenhouse which had concrete beds. The soil was slightly moistened before applying the formaldehyde. The applications on the first three plots produced no noticeable control. The amount of water applied was not sufficient to saturate the soil thoroughly. When 25 gallons more of water was applied to these same strengths, making 50 gallons, it was sufficient to saturate the soil, and completely control the organism. It is advisable that care be taken in selecting soil for the greenhouse beds from fields which have not been cropped in lettuce for three or more years. This soil should be sterilized with formaldehyde (3 pints of commercial formalin to 50 gallons of water applied at the rate of 1 gallon to the square foot). Enough water must be applied to saturate the soil. Precaution is necessary to prevent reinfection after the beds are sterilized.

The diseases of celery will be taken up more fully in a bulletin which will be issued within the next year.

REPORT OF SPRAYING TEST AT CAMPBELL'S SOUP FARMS

R. F. Poole

Spraying for the control of tomato leaf spots and other diseases has already received a good deal of attention by the plant pathology department on the Campbell's Soup Farms, near Riverton. No satisfactory results have as yet been obtained to show any advantage to be gained by spraying, nor to enable this department to recommend a specific spray schedule for tomatoes in the state. The work this year has been a continuation of the work already reported in annual reports from this station by Dr. W. H. Martin, and in Bulletin 345.

Spray applications were made July 9 and August 1 and 14, respectively. Pickings were made September 1 and 13, and October 1, 1920. A rainy season was a factor in preventing higher yields. Table 1 presents some of the results.

Table 1

Results of Tomato Spraying Tests

No.	Treatment	First Picking Sept. 1	Second Picking Sept. 13	Third Picking October 1	Total Yield per Acre
		lbs.	lbs.	lbs.	lbs.
1	Check	568.12	2474.50	429.25	5362.50
2	Bordeaux 4-4-50	1111.00	3181.50	505.00	7406.00
3	Bordeaux 0.5-0-3-50..	1237.25	4166.25	404.00	8966.00
4	Check	883.75	3307.75	429.25	7136.60
5	Bordeaux 4-4-50.....	833.25	4671.25	454.50	9204.00
6	Bordeaux 0.5-0-3-50..	580.75	2474.50	479.75	5450.00

This work will be continued. The effects of Bordeaux dust on the control of tomato leaf spots and fruit rots will be given some attention next year.

Other diseases of tomatoes have been reported to this department. The Fusarium wilt has caused a good deal of damage in some fields. The streak disease was very severe during the late summer. Anthracnose was very common on late tomatoes.

INVESTIGATION OF HORSE-RADISH ROOT ROTS

R. F. Poole

The investigation of horse-radish root rots was carried out somewhat in accordance with the work outlined in last year's report. We have learned that the most important problem to be considered in this work is an improvement of storage conditions. The rot organism spreads rapidly in the storage pits, and it is here that the infection is most severe. The temperature and moisture conditions become favorable in the spring for the development of the rots, just previous to planting time. Large roots carried over winter in storage pits for sale are more susceptible to rots than are the smaller roots, stored for seed purposes.

Presence of the Disease in the Field

Several horse-radish farms were visited during the summer and actual counts made of the number of misses in the field. Seed roots in many cases failed to germinate due to rots and this resulted in many misses. Table 1 shows the results of an inspection in August, 1920.

Table 1

Stand of Horse-Radish on Four Farms in August, 1920

Farm	Number of Plants Counted	Number	Misses
			Per cent
1	1835	271	12.9
2	1000	270	21.3
3	2000	126	5.9
4	1305	182	11.7

Less than 1 per cent of the roots which had germinated and were growing became diseased in the field.

Control Tests

Sulfur applied at the rate of 432, 648, 972 and 1080 pounds per acre and hydrated lime applied at the rate of 1080, 2160 and 2700 pounds did not affect the yield in any way. The amount of disease on the areas to which these compounds were applied was small and no disease control due to these mixtures could be estimated.

Roots selected at digging time became diseased very similar to unselected roots, when they were stored in the pits. Careful selection of seed roots in the spring at planting time, and soaking them in corrosive sublimate or formaldehyde solutions showed that the number of misses in the field could be reduced by proper selection and treatment. Table 2 gives the results of the test.

Table 2

Effect of Cutting Horse-Radish Roots to Control Rot

Number	Treatment		Time of treatment	Number of roots soaked	Number	Misses
	Material	Strength	Minutes			Per cent
1	Formaldehyde	3 pt. (Commercial formalin) to 50 gal. water	60	364	46	11.5
2	Formaldehyde	3 pt. (Commercial formalin) to 50 gal. water	30	743	65	8.0
3	Corrosive Sublimate	1 to 1000	20	481	25	4.9
4	Corrosive Sublimate	1 to 1000	10	488	33	6.3
5	Selected root	Both ends cut; those showing any discoloration were thrown out	..	1211	99	7.6
6	Check	No treatment	..	1305	182	12.2

The results of this experiment indicate that roots should be carefully selected for planting. Both ends should be cut, and those showing a disease discoloration sorted and thrown out. The selected roots should then be soaked in a corrosive sublimate solution as used above, dried and planted. This work will be continued, and storage conditions will be given more attention.

It is hoped that this work will be sufficiently advanced during the coming year so that it can be published in bulletin form.

INVESTIGATION OF SWEET-POTATO DISEASES

R. F. Poole

Since July, 1920, a very thorough investigation has been made of the sweet-potato disease situation in the state. Inspections were made in order to ascertain the extent of loss due to "stem rot," "black rot," "soil rot," "scurf," and other field diseases, and also to locate severely infested fields of these diseases for experimental work. Storage houses also were inspected in several counties during the winter. These inspections have given us a very good view of the amount of experimental work needed along lines of sweet-potato disease control, both in the field and in the storage house. They have also aided us in locating severely infested areas of the different diseases, which are most suitable for making control tests.

Stem-Rot Control Work

For several years "stem rot" has caused heavy sweet-potato losses in this state, especially in Gloucester County. At digging time in 1919 the county agent of Gloucester County and the writer selected 21 bushels of sweet potatoes by splitting the vines, and throwing out all those that showed discoloration due to the "stem rot" organisms. In the fields where the selection was made, 33 per cent of the sweet-potato vines were infected with stem rot. The potatoes were stored under normal conditions in a storage house at Swedesboro. The selected seed was sorted at bedding time and specimens showing diseases (less than 5/8 bushel) were thrown out. The potatoes were soaked from 8 to 10 minutes in a bichloride of mercury solution (1 to 1000). After soaking they were immediately bedded in a flue-heated hot-bed. Before bedding the potatoes the bed was thoroughly cleaned, salt-hay placed over the flooring, and about 3 inches of clean sandy soil added. After the potatoes were laid in the bed, they were covered with 3 inches of clean soil. The sprouts were grown by John Hunt, a very capable sweet-potato grower at Swedesboro.

On May 26 the sprouts were pulled and equally divided among 5 sweet-potato growers, each getting about 4,000 plants. These plants were kept separated from those grown by the growers, but were planted in the same field in order to get some comparison. Three inspections were made during the summer. The total number of plants and those diseased with stem-rot were counted. Table 1 gives the results.

Table 1

Results of Sweet-Potato Stem Rot Disease Control Experiments in Gloucester County

Experiment No.	Selection	Total Plants Counted July 22	Diseased Plants July 22	Total Plants Counted August 23	Diseased Plants August 23	Diseased Plants September 28
			per cent		per cent	per cent
1	Experiment Station.....	4144	1.88	4144	3.19	5.08
	Grower	1543	2.85	4043	6.30	8.70
2	Experiment Station.....	2819	4.61	2819	4.90	11.20
	Grower	1206	4.47	2814	6.20	14.65
3	Experiment Station.....	2626	3.38	2626	5.20	11.60
	Grower	1170	5.81	2473	6.90	14.00
4	Experiment Station.....	3413	5.27	3413	9.70	20.70
	Grower	1164	4.81	3145	14.70	30.20
5	Experiment Station.....	3389	1.41	3889	1.70	3.60
	Grower	1316	1.36	3947	2.30	3.90
6	No treatment.....	....	....	1100	26.00	51.00

These experiments were made to determine if the stem-rot disease can be reduced. Sweet potatoes actually infected with the "stem rot" were not bedded to compare with those selected. There are sufficient data available to show that heavy infection of "stem rot" occurs when carelessly selected sweet-potato seed is taken from an infected field. This is the result of one year's experimental work. The data given show favorable control results for one season, and the tests will be continued another year along the same line.

There are many climatic and seasonal differences in the counties in which sweet potatoes are grown in this state and there is more "stem rot" in some counties than in others. Sweet potatoes were selected at digging time in several of the other counties, treated and bedded according to the program followed in Gloucester County. This will give us further data on "stem rot" control.

Other Experiments

A very extensive experiment for the control of "soil rot" has been arranged in Gloucester County in cooperation with the extension division and the county board of agriculture. Sulfur, lime, acid phosphate, nitrogen and potash in varying strengths have been applied to an area on which 85 per cent or more of the total roots were infected with soil rot at digging time. The plots are sufficiently large, and should show average results. This experiment covers more than 3 acres and will require a good deal of time.

Inspections at digging time showed that 50 per cent or more of the potatoes harvested in New Jersey were affected with soil stain, also known as "scurf." This disease was very severe when manure and other organic matter were applied in the row or in the hill. Several experiments have been arranged to find out definitely how the disease is disseminated and to study control methods.

Black rot has been severe on some farms. Seed was selected at digging time in the infected fields. Potatoes selected for seed were soaked 10 minutes in a bichloride of mercury solution (1 to 1000) and bedded in a sanitary hot-bed. Close observation will be taken of the spread of the disease in the field.

Up to this time investigations of stem-rot control have been confined to Gloucester County. This year attention is being given to the Fusarium wilt in most of the southern counties at the request of growers from Atlantic, Camden and Burlington counties. Severe cases of black-rot infection have been called to our attention. The practice of selecting seed at digging time, treatment at bedding time and growing sprouts under sanitary conditions, is receiving a good deal of attention.

The results on the control of stem rot are very largely due to the work of Dr. L. L. Harter, of the U. S. Bureau of Plant Industry, and L. A. Cooley, county agent of Gloucester County. The latter has devoted a good deal of attention to the work along with the writer.

STUDIES ON EGGPLANT WILT

C. M. HAENSELER

The eggplant growers of southern New Jersey have suffered serious losses for many years due to the eggplant wilt caused by a species of *Verticillium*. Very little experimental work has been done on the eggplant wilt and consequently little is known about this disease except the knowledge gained by observations. There has even been some uncertainty as to the identity of the causal organism.

Some experimental studies were carried out during the spring and summer of 1920 to determine (a) the species of organism causing the eggplant wilt in New Jersey and (b) the time and manner of infection.

A number of collections of wilted eggplants were made in the fall of 1919 and examined for possible wilt organisms. All the plants showing characteristic wilt symptoms revealed the presence of a fungus growth in the vascular tissue when examined microscopically in cross-sections. The fungous hyphæ were noted in the secondary roots, primary roots, the main stem and the secondary branches to within a few inches of the growing tip. No hyphæ were found in the pedicel of the fruit.

Tissue cultures were made from a number of plants, the ordinary precautions being taken to prevent contamination. Pure cultures of *Verticillium albo-atrum* were obtained in almost every case.

Inoculation experiments with the isolated organism were carried out as follows:

The soil in two flats was thoroughly sterilized with formaldehyde (3 pints of formalin to 50 gallons of water) and allowed to dry for 10 days. One of these flats was heavily inoculated with a spore and mycelium suspension of *V. albo-atrum* and the other was left uninoculated. Both flats were seeded with eggplant seed of the American Black Beauty variety. When the seedlings were 5 weeks old they were "spotted" into a transplant bed as would ordinarily be done in farm practice. This transplant bed had been sterilized with formaldehyde and after drying, one-half was inoculated heavily with *V. albo-atrum*. The seedlings from the sterile seed-bed were set into the transplant bed, one-half into the inoculated portion and one-half into the sterile portion. Likewise the seedlings from the inoculated seed-bed were transplanted, part into inoculated and part into the sterile soil.

When the plants were about 4 to 5 inches high they were set into the field on a plot of ground which had not grown eggplants previously. One month after transplanting into the field one-half of the plants were inoculated with *V. albo-atrum* by puncture just below the ground level.

If we designate those plants which were from the inoculated seed-bed by *S*, those from the sterile seed-bed by *s*, those from the inoculated transplant bed by *T*, those from the sterile transplant bed by *t*, those which were puncture-inoculated in the field by *F*, and those which were not puncture-inoculated in the field by *f*, we have the following group of treatments with 10 plants to each group:

stf. Sterile seed-bed, sterile transplant bed, not puncture-inoculated.
stF. Sterile seed-bed, sterile transplant bed, puncture inoculated.
Stf. Inoculated seed-bed, sterile transplant bed, not puncture-inoculated.
StF. Inoculated seed-bed, sterile transplant bed, puncture-inoculated.
sTf. Sterile seed-bed, inoculated transplant bed, not puncture-inoculated.
sTF. Sterile seed-bed, inoculated transplant bed, puncture-inoculated.
STf. Inoculated seed-bed, inoculated transplant bed, not puncture-inoculated.
STF. Inoculated seed-bed, inoculated transplant bed, puncture-inoculated.

The plants were carefully observed during the summer for symptoms of wilt. Typical wilt occurred only in a very few plants but the effects of the disease were shown in most of the inoculated plants by a slow growth, small fruit and a premature dying of the oldest leaves. One of the 10 check plants (*stf*) suddenly developed a very severe case of typical wilt between September 10 and 15, but the other 9 plants remained in the prime of condition until frost.

The plants inoculated in the seed-bed only (*Stf*) or in the transplant bed only (*sTf*) were not seriously affected but showed some signs of disease in a number of plants.

The plants inoculated both in the seed-bed and the transplant bed (*STf*) showed slightly more dwarfing and a more rapid dying of the old leaves.

The most severe effects were gotten in the plants puncture-inoculated in the field (*stF, StF, sTF* and *STF*). All of these plants showed severe dwarfing due to the inoculation, and also bore a poor crop and lost the old leaves prematurely. But in spite of these injurious effects there was no typical wilting, the tips remaining in a growing condition until frost. Plants wounded by puncture but not inoculated showed no ill effects whatever.

Table 1 shows the average height of the 10 plants of each group, the measurement being the distance from the ground level to the end of the main branch.

Table 1

Height of Eggplants Receiving Different Treatments

Plant Group	Height	Relative Height
	in.	
stf.	28.7	100.0
stF.	23.7	82.6
Stf.	26.6	92.7
StF.	23.1	80.5
sTf.	27.6	96.2
sTF.	23.7	82.6
STf.	26.2	91.3
STF.	23.7	82.6

Although there are noticeable differences shown in this table, these differences were much more conspicuous in the field, due to the premature dying of the oldest leaves on the diseased plants. There was also a difference in the size of the main stem in the inoculated and the uninoculated plants. For example, the average diameter of the 10 check plants (*stf*), 1 inch above the ground level was 19.2 mm. The ten plants in the adjacent row, which were puncture-inoculated in the field (*stF*) had an average diameter of 14.4 mm., a difference of 4.8 mm. in favor of the uninoculated plants.

Microscopic examinations of every plant in the 8 lots were made to determine whether or not a vascular mycelium could be located. The check plants (*stf*) showed only one plant with a vascular fungus, and with the exception of this plant the wood was healthy and light-colored. Eighty-eight per cent of the inoculated plants showed a darkening of the vascular bundles and 61 per cent of the inoculated plants showed a vascular fungus by microscopic examination. It was noted that a plant which showed a premature dying of the old leaves, a dwarfing of the plant and a darkening of the vascular tissue frequently failed to show the presence of a mycelium in the vessels. This was also noted in material collected in the field. Whether the fungus in these cases had disintegrated or whether it was localized in some part of the plant was not determined. Frequently a badly diseased plant showed only traces of the organism in the vascular system and in such cases it was difficult to account for the wilting on the ground that the water supply had been cut off by the clogging of the tracheary tubes, an explanation that is generally given for the vascular "wilts."

A duplicate of the above test was carried out in another field where eggplants had been grown a few years before. All of the plants in

this test developed wilt symptoms, no differences being apparent between the check and the inoculated plants. This was evidently due to the presence of the wilt organism in the field and the infection of the plants after transplanting.

One field observation was made which is worthy of mentioning in connection with these studies. In 1919, Roscoe Bateman, of Grenloch, N. J., suffered considerable loss from eggplant wilt. In 1920 he planted on "new" land where eggplants had not been grown for many years, if ever. The major part of this new field was manured with manure purchased from the city market but a narrow strip received manure produced on the home farm. The plants grown on the area receiving city manure bore a fine crop of fruit and showed only a very small percentage of wilt, and that late in the season. The plants grown on the area receiving the home-made manure, on the other hand, failed to make a good growth and produced practically no marketable fruits. All these plants were affected by the wilt disease as was shown by the dwarfed condition, the darkening of the vascular tissue and the premature dying of the old leaves.

It seems evident that in this case the disease was carried in the manure. Although such observational evidence is not convincing, yet it should be taken as a caution against using manures which are liable to contain the wilt organism.

A test was made to determine whether or not seed taken from the fruit of wilted plants carries the wilt organism. Two ripe fruits were collected from plants which by external symptoms and by microscopic and cultural tests proved to be badly affected with *Verticillium* wilt. These fruits were surface-sterilized and cut open with a sterile knife. Five seeds from each of the fruits were plucked out with sterile forceps and placed into flasks containing nutrient agar, one seed being placed in each flask. Five other seeds were taken from each of the fruits and cut into halves and put into flasks of agar. These twenty cultures were incubated for 30 days at 29°C. Three of the flasks developed bacterial contamination but no fungus developed in any of the cultures. This test would indicate that the wilt organism does not advance into the seed of fruits borne on badly diseased vines.

Attempts to infect tomato and pepper plants with the *Verticillium* taken from wilted eggplants gave negative results.

SPRAYING EXPERIMENT FOR THE CONTROL OF PEAR FRUIT AND LEAF SPOT

C. M. HAENSELER

A spraying experiment was conducted in the spring of 1920 in a pear orchard owned by the Minch Bros., Bridgeton, N. J., to determine the relative efficiency of various spray mixtures in controlling the pear fruit and leaf spot caused by *Fabræa maculata*. The orchard was blocked off into five plots of about 30 to 40 trees each, and the plots sprayed as follows:

Plot 1. Check—no spray.
Plot 2. Commercial concentrated lime-sulfur; 1 gallon to 40 gallons of water.
Plot 3. Bordeaux mixture. 3-4-50.
Plot 4. Self-boiled lime-sulfur. 8-8-50.
Plot 5. Pyrox.

Three pounds of dry arsenate of lead per 100 gallons of spray was added to each of the mixtures except the Pyrox. Four spray applications were made; on May 17, May 27, June 9 and July 30, respectively.

During the summer the unsprayed plot developed considerable fruit and leaf spot and an examination made on September 22 showed that many of the unsprayed trees had lost one-half or more of their leaves as a result of the disease.

The commercial lime-sulfur, Bordeaux mixture, and Pyrox all gave a complete control of the fruit and leaf spot, but these mixtures caused more or less spray injury to the pear fruit. Although this spray injury did not affect the yield it was sufficient to mar the general appearance and consequently decrease the market value of the fruit.

On the self-boiled lime-sulfur plot a small amount of disease developed but the attack was not severe enough to cause any appreciable damage. The fruit on this plot did not show any signs of spray injury and was much smoother and better in general appearance than that from any of the other plots. Since the self-boiled lime-sulfur gave a practical control of the disease, and at the same time left the fruit in such perfect market condition, it may be concluded that the self-boiled lime-sulfur gave slightly better results in this experiment than did the other three spray mixtures.

This experiment was planned to compare the relative value of various spray mixtures in controlling the pear fruit and leaf spot and not to work out a complete spray calendar for this disease. The number of applications necessary to insure a complete control and the best time to apply these is still a problem to be solved, and will be taken up during the coming year.

Until a complete spray schedule has been experimentally worked out it will doubtless be best to use a schedule similar to that used so successfully in the above tests. From these tests we know that good results may be expected from four applications of self-boiled lime-sulfur, beginning about 10 days after petal fall, giving the first three sprays at 10 to 14-day intervals and the fourth spray about 3 weeks after the third. This treatment should give clean, smooth fruit and leave the trees in a vigorous condition to produce strong healthy fruiting spurs for the following year's crop.

FIG. 1. BLACK ROT, A BACTERIAL DISEASE OF CABBAGE. NOTE DARKENING OF VEINS DUE TO ATTACK OF ORGANISM. *Bacterium campestris.*

FIG. 2. BACTERIAL SOFT ROT OF CARROT, DUE TO *Bacillus carotovurs* Jones.

FIG. 1. LEAF SCORCH OF MAPLE.

FIG. 2. BUD ROT OF ROSES. *Botrytis* sp.

FIG. 1. THE STREAK DISEASE OF TOMATO.

FIG. 2. LEAF MOLD OF TOMATO. *Cladosporium fulvum.*

FOLIAGE INJURIES

MEL. T. COOK

During the spring and early summer of 1921 we had an exceptionally large number of inquiries concerning the scalding and falling of the foliage of trees. Most of these inquiries were concerning the foliage of sugar maple, Norway maple and beech, but some inquiries were made in regard to apple and cherry.

In this connection we must again call attention to warm weather in the early spring followed by frosts which destroyed the greater part of the peach and cherry crop and very greatly reduced the apple crop. The frost came when the young foliage was very susceptible to injury and the effects were noticeable on forest, shade and fruit trees. Furthermore, many leaves that did not show injury at that time fell in great abundance later in the season. This was very frequently confused with falling due to other causes. The greatest confusion was in regard to the cherry in which the falling was partly due to the early frost and partly to the leaf spot fungus *Cylindrosporium padi.*

The leaf-scald of the shade trees was due primarily to the lack of both water and food. City drainage is planned to get rid of the water as rapidly as possible, which makes it impossible for any considerable amount to penetrate the soil. Furthermore, the soil surface is reduced by the pavements. Since trees cannot get the mineral foods of the soil without water, they suffer for want of both water and food. The transpiration is increased by the reflected heat from the pavements and buildings. The result is the scalding or the falling of the foliage, and in some cases both.

This can be controlled to some extent by pruning out 25 per cent or more of the branches in the fall, by giving good applications of fertilizers in the spring and by loosening the soil around the trees so as to permit the water to enter the soil.